LISTING OF THE CLAIMS

1. (Original) An electrochemical gas sensor for quantitative measurement of a gas in a ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material; whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

2. (Original) The electrochemical gas sensor as defined in claim 1, wherein said water vapor containing means contains a volume of water and an antifreeze additive.

3. (Original) The electrochemical gas sensor as defined in claim 1, wherein the surface of said sensing electrode that is exposed to the ambient atmosphere has a surface area that is smaller than the surface area of the surface of the counter electrode that is exposed to said water vapor, whereby the first protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor

exists from the surface of said counter electrode exposed to said water vapor to the surface of said sensing electrode exposed to the ambient atmosphere.

4. (Original) The electrochemical gas sensor as defined in claim 3, wherein the surface area of the surface of the counter electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

5. (Original) The electrochemical gas sensor as defined in claim 1, wherein the first protonic conductive electrolyte membrane has opposing surfaces, each of said opposing surfaces being in contact with one of the sensing and counter electrodes, wherein at least one of the opposing surfaces of said first protonic conductive electrolyte membrane in contact with one of the sensing and counter electrodes is substantially nonplanar.

6. (Original) The electrochemical gas sensor as defined in claim 1, wherein at least one of the sensing and counter electrodes is comprised of film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

7. (Original) The electrochemical gas sensor as defined in claim 6, wherein the film is substantially composed of a noble metal.

8. (Original) The electrochemical gas sensor as defined in claim 7, wherein the noble metal is platinum.

9. (Original) The electrochemical gas sensor as defined in claim 1, wherein the first protonic conductive electrolyte membrane is substantially composed of a solid, perfluorinated, ion-exchange polymer.

10. (Original) The electrochemical gas sensor as defined in claim 1, wherein the first protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

11. (Original) The electrochemical gas sensor as defined in claim 1, wherein the proton conductor material for said at least one of the sensing and counter electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

12. (Original) The electrochemical gas sensor as defined in claim 1, wherein one of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 1-50 wt % of platinum.

13. (Original) The electrochemical gas sensor as defined in claim 1, wherein one of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 1-50 wt % of Ru oxide.

14. (Original) The electrochemical gas sensor as defined in claim 1, wherein the electrochemical gas sensor further comprises:

first and second pump electrodes comprised of an electrical conducting material permeable to water vapor, separate from said sensing and counter electrodes, and situated on opposite sides of and in contact with said first protonic conductive electrolyte membrane, said second pump electrode being situated on the same side of said first protonic conductive membrane as the counter electrode and having a surface thereon exposed to the water vapor in said means for exposing a surface of said counter electrode to said water vapor; and

means for applying a DC power across the first protonic conductive electrolyte membrane, said first and second pump electrodes having in electrical connection therebetween said means for applying DC power across the first protonic conductive electrolyte membrane;

whereby the gas is transported away from the counter electrode when the DC power means applies a DC power to the first and second pump electrodes.

15. (Original) The electrochemical gas sensor of claim 14, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of carbon.

16. (Original) The electrochemical gas sensor as defined in claim 14, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of noble metals.

17. (Original) The electrochemical gas sensor as defined in claim 14, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of conductive hydrated metal oxides.

18. (Original) The electrochemical gas sensor as defined in claim 14, wherein at least one of the first and second pump electrodes is comprised of a film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

19. (Original) The electrochemical gas sensor as defined in claim 14, wherein the electrical conducting material of said first and second pump electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

20. (Original) The electrochemical gas sensor as defined in claim 19, wherein the proton conductor material for both the first and second pump electrodes is a copolymer having a

tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

21. (Original) The electrochemical gas sensor as defined in claim 19, wherein one of the first and second electrical conductor materials for the first pump electrode is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for the first pump electrode is 1 to 50 wt % of platinum.

22. (Original) The electrochemical gas sensor as defined in claim 19, wherein one of the first and second electrical conductor materials for the second pump electrode is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for the second pump electrode is 1 to 50 wt % of Ru oxide.

23. (Original) The electrochemical gas sensor as defined in claim 1, wherein the electrochemical gas sensor further comprises:

a second protonic conductive electrolyte membrane permeable to water vapor;

first and second pump electrodes permeable to water vapor and comprised of an electron conductive material, and being separate from said sensing and counter electrodes and situated on opposite sides of and in contact with said second protonic conductive electrolyte membrane, said means for exposing a surface of said counter electrode to said water vapor exposing a surface of said second pump electrode to said water vapor, and said first pump electrode having a surface exposed to the ambient atmosphere; and

means for applying a DC power across said second protonic electrolyte membrane, said first and second pump electrodes having in electrical connection therebetween said means for applying DC power across said second protonic electrolyte membrane;

whereby the gas is transported away from the counter electrode when the DC power means applies a DC power to the first and second pump electrodes.

24. (Original) The electrochemical gas sensor as defined in claim 23, wherein the second protonic conductive electrolyte membrane is substantially composed of a solid, perfluorinated, ion-exchange polymer.

25. (Original) The electrochemical gas sensor as defined in claim 23, wherein the second protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

26. (Original) The electrochemical gas sensor as defined in claim 23, wherein the surface area of the surface of said first pump electrode that is exposed to the ambient atmosphere is smaller than the surface area of the surface of the second pump electrode that is exposed to said water vapor, whereby the second protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said second pump electrode that is exposed to said water vapor to the surface of said first pump electrode that is exposed to the ambient atmosphere.

27. (Original) The electrochemical gas sensor as defined in claim 26, wherein the surface area of the surface of the second pump electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

28. (Original) The electrochemical gas sensor as defined in claim 1, further comprising:

means for applying a DC pulse power source across the first protonic conductive membrane, said sensing and counter electrodes having in electrical connection therebetween said means for applying DC pulse power across the first protonic conductive membrane; and

switch means for alternating the connection between the sensing and counter electrodes from the electrical measurement means to the DC pulse power means;

whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic when said switch means connects said electrical measurement means to the sensing and counter electrodes; and

whereby said DC pulse power means moves the gas away from a side of the gas sensor where the counter electrode is placed when said switch means connects said DC pulse power means to the sensing and counter electrodes.

29. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is CO.

30. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is NO_x.

31. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is hydrogen.

32. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is H_2S.

33. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is H_2O vapor.

34. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is alcohol vapor.

35. (Original) An electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated in between and in contact with the sensing and counter electrodes, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

a second protonic conductive electrolyte membrane permeable to water vapor;

first and second pump electrodes permeable to water vapor and comprised of an electrical conductive material, and being separate from said sensing and counter electrodes and situated on opposite sides of and in contact with said second protonic conductive electrolyte membrane;

means, containing a volume of water vapor, for exposing a surface of said second pump electrode to said water vapor, and said first pump electrode having a surface exposed to the ambient atmosphere, said second pump electrode being separated from said counter electrode by said means for exposing a surface of said second pump electrode to said water vapor, and said counter electrode having a surface exposed to said water vapor by said means for exposing a surface of said second pump electrode to said water vapor;

means for electrical measurement in electrical communication with said sensing electrode and said counter electrode; and

means for applying a DC power across said second protonic electrolyte membrane in electrical contact with said first and second pump electrodes;

whereby the gas is transported away from the counter electrode when the DC power means applies a DC power across said second protonic electrolyte membrane; and whereby, in a positive ambient concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

36. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of said first and second protonic conductive electrolyte membranes is substantially comprised of a solid, perfluorinated, ion-exchange polymer.

37. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of the first and second protonic conductive electrolyte membranes is a hydrated metal oxide protonic conductor electrolyte membrane.

38. (Original) The electrochemical gas sensor as defined in claim 35, wherein the surface of said first pump electrode that is exposed to the ambient atmosphere has a surface area smaller than the surface area of the surface of the second pump electrode that is exposed to said water vapor, and wherein the surface of said sensing electrode that is exposed to the ambient atmosphere has a surface area smaller than the surface area of the surface of the counter electrode that is exposed to said water vapor, whereby the first protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, a positive pressure of said water vapor exists from the surface of said counter electrode that is exposed to said water vapor to the surface of said sensing electrode that is exposed to the ambient atmosphere, the second protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said second pump electrode that is exposed to said water vapor to the surface of said first pump electrode that is exposed to the ambient atmosphere.

39. (Original) The electrochemical gas sensor as defined in claim 38, wherein the surface area of each of the surfaces of the second pump and counter electrodes that are exposed to said water vapor by said means for exposing a surface of said second pump electrode to said water vapor are each separated from said means for exposing a surface of said second pump electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

40. (Original) The electrochemical gas sensor as defined in claim 35, wherein said means for exposing a surface of said second pump electrode to said water vapor further contains an antifreeze additive.

41. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of the surfaces of said first protonic conductive electrolyte membrane in contact with one of the sensing and counter electrodes is substantially nonplanar, and wherein at least one of the surfaces of said second protonic conductive electrolyte membrane in contact with one of the first and second pump electrodes is substantially nonplanar.

42. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of the sensing, counter, first pump, and second pump electrodes is comprised of film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

43. (Original) The electrochemical gas sensor as defined in claim 42, wherein the film is substantially composed of a noble metal.

44. (Original) The electrochemical gas sensor as defined in claim 43, wherein the noble metal is platinum.

45. (Original) The electrochemical gas sensor as defined in claim 35, wherein the at least one of the sensing, counter, first pump, and second pump electrodes is substantially comprised of proton conductive material.

46. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of the first and second protonic conductive electrolyte membranes is substantially comprised of a solid, perfluorinated, ion-exchange polymer.

47. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of the first and second protonic conductive electrolyte membranes is a hydrated metal oxide protonic conductive electrolyte membrane.

48. (Original) The electrochemical gas sensor as defined in claim 35, wherein the electrical conducting material of at least one of said sensing, counter, first pump, and second pump electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

49. (Original) The electrochemical gas sensor as defined in claim 48, wherein the proton conductor material for said at least one of the sensing, counter, first pump, and second pump electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

50. (Original) The electrochemical gas sensor as defined in claim 48, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, first pump, and second pump electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, first pump and second pump electrodes is about 1-50 wt % of platinum.

51. (Original) The electrochemical gas sensor as defined in claim 48, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, first pump, and second pump electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, first pump, and second pump electrodes is about 1-50 wt % of Ru oxide.

52. (Original) An electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and being exposed to the ambient atmosphere;

a reference electrode permeable to water vapor and comprised of an electrical conducting material;

a counter electrode permeable to water vapor and comprised of an electrical conducting material and being separate from both said sensing and reference electrodes, and being exposed to the ambient atmosphere;

a protonic conductive electrolyte membrane permeable to water vapor, having top and bottom sides, said bottom side of said protonic conductive membrane being in contact with the counter electrode, and the top side of said protonic conductive membrane being in contact with the sensing and reference electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode; and

means for electrical measurement in electrical contact between the sensing electrode and the counter electrode, wherein the electrical conducting material of at least one of said sensing, counter, and reference electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

53. (Original) The electrochemical gas sensor as defined in claim 52, further comprising:

means for applying a DC power across said protonic electrolyte membrane in electrical contact between the sensing electrode and said counter electrode, whereby the gas is transported away from the counter electrode when the DC power means applies a DC power across said protonic electrolyte membrane.

54. (Original) The electrochemical gas sensor as defined in claim 52, wherein said means for exposing a surface of said counter electrode to said water vapor further contains an antifreeze additive.

55. (Original) The electrochemical gas sensor as defined in claim 52, wherein the surface of said sensing electrode that is exposed to the ambient atmosphere has a surface area smaller than the surface area of the surface of the counter electrode that is exposed to said water vapor, whereby the first protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said counter electrode that is exposed to said water vapor to the surface of said sensing electrode that is exposed to the ambient atmosphere.

56. (Original) The electrochemical gas sensor as defined in claim 55, wherein the surface area of the surface of the counter electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

57. (Original) The electrochemical gas sensor as defined in claim 52, wherein at least one of the surfaces of said protonic conductive electrolyte membrane in contact with one of the sensing, counter, and reference electrodes is substantially nonplanar.

58. (Original) The electrochemical gas sensor as defined in claim 52, wherein at least one of the sensing, counter, and reference electrodes is comprised of film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

59. (Original) The electrochemical gas sensor as defined in claim 58, wherein the film is substantially composed of a noble metal.

60. (Original) The electrochemical gas sensor as defined in claim 59, wherein the noble metal is platinum.

61. (Original) The electrochemical gas sensor as defined in claim 52, wherein the protonic conductive electrolyte membrane is substantially comprised of a solid, perfluorinated, ion-exchange polymer.

62. (Original) The electrochemical gas sensor as defined in claim 52, wherein the protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

63. (Original) The electrochemical gas sensor as defined in claim 52, wherein the proton conductor material for said at least one of the sensing, counter, and reference electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

64. (Original) The electrochemical gas sensor as defined in claim 52, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 1-50 wt % of platinum.

65. (Original) The electrochemical gas sensor as defined in claim 52, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 1-50 wt % of Ru oxide.

Claim 66. (Currently Amended) A two-electrode electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode and the counter electrode being the only two electrodes in contact with the first protonic conductive electrolyte membrane and the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor,

wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

Claim 67. (Currently Amended) An electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing

electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor,

wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

Claim 68. (Cancelled)

Claim 69. (Cancelled)

Claim 70. (Previously Presented) The electrochemical gas sensor of claim 77 in which the sensing electrode and the counter electrode are the only two electrodes in contact with the first protonic conductive electrolyte membrane.

Claim 71. (Previously Presented) The electrochemical gas sensor of claim 77 in which the sensing electrode reacts with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode.

Claim 72. (Previously Presented) The electrochemical gas sensor of claim 70 in which the sensing electrode reacts with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode.

Claim 73. (Twice Amended) A non-biased electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor,

wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic in the absence of any biasing voltage.

Claim 74. (Previously Presented) The non-biased electrochemical gas sensor of claim 73 in which the sensing electrode and the counter electrode are the only two electrodes in contact with the first protonic conductive electrolyte membrane.

Claim 75. (Cancelled) ~~The non-biased electrochemical gas sensor of claim 73 in which the sensing electrode reacts with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode.~~

Claim 76. (TwiceAmended) A two-electrode electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode and the counter electrode being the only two electrodes in contact with the first protonic conductive electrolyte membrane, and the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor,

wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

Claim 77. (Twice Amended) An electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode, the sensing electrode and the counter electrode being on opposite sides of the first protonic conductive electrolyte membrane;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor,

wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

Claim 78. (Currently Amended) An electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere at room temperature comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes, said means for electrical measurement being capable of detecting changes in said electrical characteristic in a positive ambient atmosphere concentration of said gas;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor,

wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

Claim 79. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein said water vapor containing means contains a volume of water and an antifreeze additive.

Claim 80. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the surface of said sensing electrode that is exposed to the ambient atmosphere has a surface area that is smaller than the surface area of the surface of the counter electrode that is exposed to said water vapor, whereby the first protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said counter electrode exposed to said water vapor to the surface of said sensing electrode exposed to the ambient atmosphere.

Claim 81. (Previously Presented) The electrochemical gas sensor as defined in claim 80, wherein the surface area of the surface of the counter electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

Claim 82. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the first protonic conductive electrolyte membrane has opposing surfaces, each of said opposing surfaces being in contact with one of the sensing and counter electrodes, wherein at least one of the opposing surfaces of said first protonic conductive

electrolyte membrane in contact with one of the sensing and counter electrodes is substantially nonplanar.

Claim 83. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein at least one of the sensing and counter electrodes is comprised of film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

Claim 84. (Previously Presented) The electrochemical gas sensor as defined in claim 83, wherein the film is substantially composed of a noble metal.

Claim 85. (Previously Presented) The electrochemical gas sensor as defined in claim 84, wherein the noble metal is platinum.

Claim 86. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the first protonic conductive electrolyte membrane is substantially composed of a solid, perfluorinated, ion-exchange polymer.

Claim 87. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the first protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

Claim 88. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the proton conductor material for said at least one of the sensing and counter electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

Claim 89. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein one of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 50-99 wt % of carbon black, and the other

of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 1-50 wt % of platinum.

Claim 90. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein one of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 1-50 wt % of Ru oxide.

Claim 91. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the electrochemical gas sensor further comprises:

first and second pump electrodes comprised of an electrical conducting material permeable to water vapor, separate from said sensing and counter electrodes, and situated on opposite sides of and in contact with said first protonic conductive electrolyte membrane, said second pump electrode being situated on the same side of said first protonic conductive membrane as the counter electrode and having a surface thereon exposed to the water vapor in said means for exposing a surface of said counter electrode to said water vapor; and means for applying a DC power across the first protonic conductive electrolyte membrane, said first and second pump electrodes having in electrical connection therebetween said means for applying DC power across the first protonic conductive electrolyte membrane;

whereby the gas is transported away from the counter electrode when the DC power means applies a DC power to the first and second pump electrodes.

Claim 92. (Previously Presented) The electrochemical gas sensor of claim 91, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of carbon.

Claim 93. (Previously Presented) The electrochemical gas sensor as defined in claim 91, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of noble metals.

Claim 94. (Previously Presented) The electrochemical gas sensor as defined in claim 91, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of conductive hydrated metal oxides.

Claim 95. (Previously Presented) The electrochemical gas sensor as defined in claim 91, wherein at least one of the first and second pump electrodes is comprised of a film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

Claim 96. (Previously Presented) The electrochemical gas sensor as defined in claim 91, wherein the electrical conducting material of said first and second pump electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

Claim 97. (Previously Presented) The electrochemical gas sensor as defined in claim 96, wherein the proton conductor material for both the first and second pump electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

Claim 98. (Previously Presented) The electrochemical gas sensor as defined in claim 96, wherein one of the first and second electrical conductor materials for the first pump electrode is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for the first pump electrode is 1 to 50 wt % of platinum.

Claim 99. (Previously Presented) The electrochemical gas sensor as defined in claim 96, wherein one of the first and second electrical conductor materials for the second pump electrode is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for the second pump electrode is 1 to 50 wt % of Ru oxide.

Claim 100. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the electrochemical gas sensor further comprises:

a second protonic conductive electrolyte membrane permeable to water vapor;

first and second pump electrodes permeable to water vapor and comprised of an electron conductive material, and being separate from said sensing and counter electrodes and situated on opposite sides of and in contact with said second protonic conductive electrolyte membrane, said means for exposing a surface of said counter electrode to said water vapor exposing a surface of said second pump electrode to said water vapor, and said first pump electrode having a surface exposed to the ambient atmosphere; and

means for applying a DC power across said second protonic electrolyte membrane, said first and second pump electrodes having in electrical connection therebetween said means for applying DC power across said second protonic electrolyte membrane;

whereby the gas is transported away from the counter electrode when the DC power means applies a DC power to the first and second pump electrodes.

Claim 101. (Previously Presented) The electrochemical gas sensor as defined in claim 100, wherein the second protonic conductive electrolyte membrane is substantially composed of a solid, perfluorinated, ion-exchange polymer.

Claim 102. (Previously Presented) The electrochemical gas sensor as defined in claim 100, wherein the second protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

Claim 103. (Previously Presented) The electrochemical gas sensor as defined in claim 100, wherein the surface area of the surface of said first pump electrode that is exposed to the ambient atmosphere is smaller than the surface area of the surface of the second pump electrode that is exposed to said water vapor, whereby the second protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said second pump electrode that is exposed to said water vapor to the surface of said first pump electrode that is exposed to the ambient atmosphere.

Claim 104. (Previously Presented) The electrochemical gas sensor as defined in claim 103, wherein the surface area of the surface of the second pump electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

Claim 105. (Previously Presented) The electrochemical gas sensor as defined in claim 78, further comprising:

means for applying a DC pulse power source across the first protonic conductive membrane, said sensing and counter electrodes having in electrical connection therebetween said means for applying DC pulse power across the first protonic conductive membrane; and

switch means for alternating the connection between the sensing and counter electrodes from the electrical measurement means to the DC pulse power means;

whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic when said switch means connects said electrical measurement means to the sensing and counter electrodes; and

whereby said DC pulse power means moves the gas away from a side of the gas sensor where the counter electrode is placed when said switch means connects said DC pulse power means to the sensing and counter electrodes.

Claim 106. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the gas is CO.

Claim 107. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the gas is NO_x.

Claim 108. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the gas is hydrogen.

Claim 109. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the gas is H_2S.

Claim 110. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the gas is H_2O vapor.

Claim 111. (Previously Presented) The electrochemical gas sensor as defined in claim 78, wherein the gas is alcohol vapor.

Claim 112. (Currently Amended) An electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere at room temperature comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and being exposed to the ambient atmosphere;

a reference electrode permeable to water vapor and comprised of an electrical conducting material;

a counter electrode permeable to water vapor and comprised of an electrical conducting material and being separate from both said sensing and reference electrodes, and being exposed to the ambient atmosphere;

a protonic conductive electrolyte membrane permeable to water vapor, having top and bottom sides, said bottom side of said protonic conductive membrane being in contact with the counter electrode, and the top side of said protonic conductive membrane being in contact with the sensing and reference electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode; and

means for electrical measurement in electrical contact between the sensing electrode and the counter electrode,

wherein the electrical conducting material of at least one of said sensing, counter, and reference electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

Claim 113. (Previously Presented) The electrochemical gas sensor as defined in claim 112, further comprising:

means for applying a DC power across said protonic electrolyte membrane in electrical contact between the sensing electrode and said counter electrode, whereby the gas is transported away from the counter electrode when the DC power means applies a DC power across said protonic electrolyte membrane.

Claim 114. (Previously Presented) The electrochemical gas sensor as defined in claim 112, wherein said means for exposing a surface of said counter electrode to said water vapor further contains an antifreeze additive.

Claim 115. (Previously Presented) The electrochemical gas sensor as defined in claim 112, wherein the surface of said sensing electrode that is exposed to the ambient atmosphere has a surface area smaller than the surface area of the surface of the counter electrode that is exposed to said water vapor, whereby the first protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said counter electrode that is exposed to said water vapor to the surface of said sensing electrode that is exposed to the ambient atmosphere.

Claim 116. (Previously Presented) The electrochemical gas sensor as defined in claim 115, wherein the surface area of the surface of the counter electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter

electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

Claim 117. (Previously Presented) The electrochemical gas sensor as defined in claim 112, wherein at least one of the surfaces of said protonic conductive electrolyte membrane in contact with one of the sensing, counter, and reference electrodes is substantially nonplanar.

Claim 118. (Previously Presented) The electrochemical gas sensor as defined in claim 112, wherein at least one of the sensing, counter, and reference electrodes is comprised of film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

Claim 119. (Previously Presented) The electrochemical gas sensor as defined in claim 118, wherein the film is substantially composed of a noble metal.

Claim 120. (Previously Presented) The electrochemical gas sensor as defined in claim 119, wherein the noble metal is platinum.

Claim 121. (Previously Presented) The electrochemical gas sensor as defined in claim 112, wherein the protonic conductive electrolyte membrane is substantially comprised of a solid, perfluorinated, ion-exchange polymer.

Claim 122. (Previously Presented) The electrochemical gas sensor as defined in claim 112, wherein the protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

Claim 123. (Previously Presented) The electrochemical gas sensor as defined in claim 112, wherein the proton conductor material for said at least one of the sensing, counter, and reference electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

Claim 124. (Previously Presented) The electrochemical gas sensor as defined in claim 112, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 1-50 wt % of platinum.

Claim 125. (Previously Presented) The electrochemical gas sensor as defined in claim 112, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 1-50 wt % of Ru oxide.

Claim 126. (Currently Amended) A residential electrochemical gas sensor for quantitative measurement of carbon monoxide gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode reacting with the carbon monoxide gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor,

wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient atmosphere concentration of the carbon monoxide gas at room temperature, said electrical measurement means detects changes in said electrical characteristic.

Claim 127. (Previously Presented) The electrochemical gas sensor of claim 126 in which the sensing electrode comprises a mixed protonic-electronic conductive electrode.

Claim 128. (Currently Amended) A two-electrode residential electrochemical gas sensor for quantitative measurement of carbon monoxide gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode and the counter electrode being the only two electrodes in contact with the first protonic conductive electrolyte membrane, and the sensing electrode reacting with the carbon monoxide gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor,

wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient atmosphere concentration of the carbon monoxide gas at room temperature, said electrical measurement means detects changes in said electrical characteristic;

wherein each of the sensing electrode and the counter electrode comprise a mixed protonic-electronic conductive electrode including platinum, carbon and a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing a sulfonic acid group; and

wherein the protonic conductive solid electrolyte membrane is substantially comprised of a solid, perfluorinated, ion-exchange polymer.

129. (Previously Presented) The two-electrode electrochemical gas sensor as defined in claim 128, wherein the sensing and counter electrodes have a diameter in a range of 1 mm to 15 mm, and the protonic conductive electrolyte membrane has a thickness in a range of 0.1 mm to 1 mm.

130. (Previously Presented) The two-electrode electrochemical gas sensor as defined in claim 128, wherein the sensing and counter electrodes have a diameter of about 15 mm, and the protonic conductive electrolyte membrane has a thickness of about 0.17 mm.

131. (Previously Presented) The two-electrode electrochemical gas sensor as defined in claim 128, wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having at least approximately 25 wt % of a proton conductor material.

132. (Previously Presented) The two-electrode electrochemical gas sensor as defined in claim 128, wherein said counter electrode is exposed to said water vapor at a 100% relative humidity.

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